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# NORTH AMERICAN ROSE RUSTS*



By J. C. Arthur

From the days of Schweinitz, that is, the times of the first studies of American fungi, down to the near present, all rusts upon roses in North America had been placed under two species, *i. e.*, *Phragmidium speciosum*, a strictly American form, and *P. subcorticium*, a cosmopolitan form. The latter name has many synonyms, *P. mucronatum* having been especially popular, but the earliest and consequently the rightful name appears to be *P. disciflorum*, and therefore will be used in this paper.

In 1876 Peck vaguely called attention in his twenty-eighth Report of the Botanist of the New York State Musuem (page 86) to a variation in teliospores that he had observed. His words are "American specimens generally have the spores more opaque, and with two or three more septa than the typical form. This variant form might be called var. *Americanum*." The variety was placed under *P. mucronatum*. Two years ago Dietel published an extended taxonomic study of the genus *Phragmidium* in Hedwigia, and five months later a supplementary article in the same journal (44 : 112–132, 330–346). In these two articles Dietel established and well defined four new species of *Phragmidium* inhabiting American roses, and one new species of *Caeoma*, *C. Rosae-gymnocarpae*, from California. This comprises all important taxonomic work upon rose rusts of America up to the present time.

In pursuing the study of American rusts for systematic presentation in the forthcoming North American Flora the genus *Phragmidium* has been reached, and I desire to give in this



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paper some of the more interesting results that have come to light pertaining to the forms on roses.

Very little has been learned about the Californian *Caeoma*. It s clearly an aecial stage of the type of *Caeoma nitens* on *Rubus*, and like it may belong to the genus *Gymnoconia*. But as no hint has yet been secured regarding the telial stage, the assignment to any other than a form-genus is hazardous.

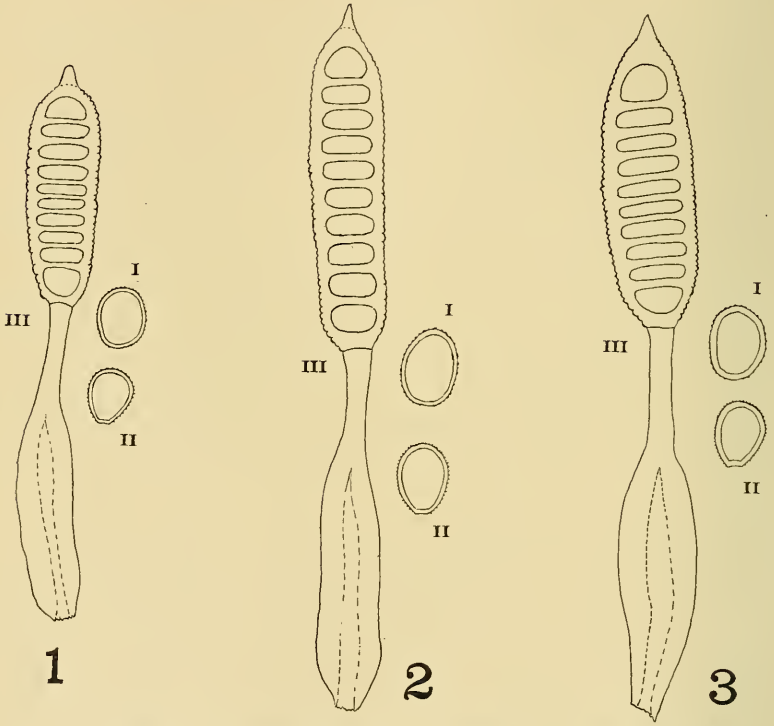


FIG. 1. Spores of the three species of *Phragmidium* on rose having slender eliospores : 1, *P. americanum*, 2, *P. Rosae-setigerae*, 3, *P. Rosae-californicae ;* I, aeciospore, II, urediniospore, III, teliospore.

The characters of the rust which has been called *Phragmidium speciosum*, such as the non-gelatinous pedicels of the teliospores, the large, compact telia, found on the stems, and the absence of a uredinial stage, show that it does not accord with true members of the genus *Phragmidium*, and justify its separation

under the name *Earlea speciosa*, made some two years ago. This rust occurs upon any and all species of roses in North America, both wild and cultivated, and extends throughout the United States and southern Canada. Its omnivorous and adaptable habits are in marked contrast with the fastidious and restricted habits of all true species of *Phragmidium* on roses found in the same region.

In carefully going over the available material of American rose rusts, properly assignable to the genus *Phragmidium*, the old world species, *P. disciflorum* and all the species erected by Dietel

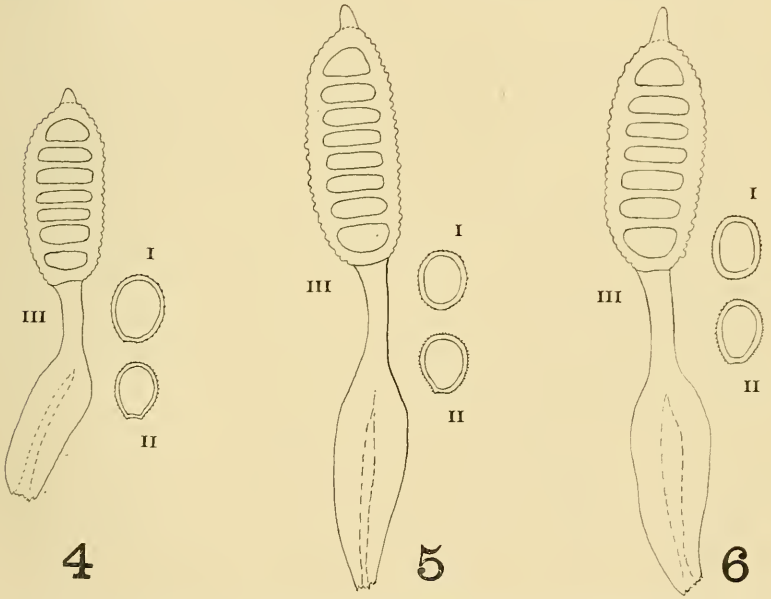


FIG. 2. Spores of the three species of *Phragmidium* on rose having stout teliospores : 4, *P. Rosae-arkansanae*, 5, *P. montivagum*, 6, *P. disciflorum ;* I, aeciospore, II, urediniospore, III, teliospore.

are confirmed, as common in North America, together with one additional species now to be described. In defining these species, characters have been drawn from all three stages of the rust, aecial, uredinial, and telial. The new species may be characterized as follows :

**Phragmidium montivagum** Arthur, n. sp.*

Pycnia amphigenous, gregarious and often confluent, in small groups surrounded by aecia or on spots opposite the aecia, inconspicuous, subcuticular, 80–112 μ in diameter by 30–35 μ high.

Aecia hypophyllous and petiolicolous, 0.4–1.5 mm. across, solitary, or in irregular groups, often confluent over areas 5–10 mm. long, applanate; paraphyses abundant, conspicuous, surrounding each individual sorus, noticeably taller than the spore-mass, spatulate-capitate or clavate, 12–25 μ by 50–70 μ, wall evenly thin, 1–1.5 μ; aeciospores globoid or broadly ellipsoid, 16–19 μ by 21–26 μ, wall medium thin, 1.5–2 μ, rather sparsely but distinctly verrucose.

Uredinia hypophyllous, numerous, scattered, round, small, about 0.1 mm. or less across, soon naked, inconspicuous; paraphyses numerous and noticeable, encircling the sorus, cylindrical or slightly clavate, 9–11 μ by 45–64 μ, wall thin, about 1 μ, slightly thicker above on outer side of curve; urediniospores obovate-globoid, 16–19 μ by 19–23 μ, wall pale yellow, rather thin, 1–1.5 μ, closely verrucose-echinulate.

Telia hypophyllous, at first arising from the uredinia, numerous, thickly scattered, 0.1–0.5 mm. across; paraphyses none; teliospores cylindrical, 24–29 μ by 64–96 μ, usually rounded below and narrowed above, cells 6–9, closely and rather moderately verrucose, apex usually with a conical subhyaline papilla 7–10 μ long; pedicel rugose when dry, upper half 7–9 μ in diam, eter, lower part swelling in water to 15–30 μ at broadest part.

On *Rosa Sayi* Schw., Cummins, Albany Co., Wyo., July 26, 1895, *Aven Nelson 1499* (type), Crow Creek, Albany Co., Wyo., August 12, 1903, *Aven Nelson 8913*, Belt Mountains, Mont.,

* Pycniis amphigenis, in greges dispositis, inconspicuis, 80–112 μ diam., 30–35 μ altis.

Aeciis hypophyllis vel petiolicolis, 0.4–1.5 mm. latis, saepe confluentibus, applanatis; paraphysibus conspicuis, marginalibus; aeciosporis subglobosis vel ellipsoideis, 16–19 × 21–26 μ; episporio subhyalino, 1.5–2 μ crasso, verruculoso.

Urediniis hypophyllis, numerosis, minutis, rotundatis; paraphysibus cylindraceis vel clavatis, marginalibus; urediniosporis obovato-globosis, 16–19 × 19–23 μ; episporio dilute flavo, 1–1.5 μ crasso, verrucoso-echinulato.

Teliis hypophyllis, numerosis, sparsis; teliosporis cylindraceis, 24–29 × 64–96 μ, verrucosis, 5–8-septatis, loculo terminali apiculo conoideo hyalino 7–10 μ longo ornato; pedicello supra 7–9 μ diam., infra incrassato, oblanceolato vel ellipsoideo, 15–30 μ late.

In foliis *Rosa Sayi*, Cummins, Wyoming, Julo 26, 1895, *Aven Nelson, 1499.*

September, 1889, *F. W. Anderson;* and also on related species of hosts from Colorado and Utah northward in the Rocky Mountains.

Of the rose rusts in North America belonging to the restricted genus *Phragmidium* there are now to be recognized six valid species, all indigenous but one. Space does not permit, and the needs of this discussion do not require the full characterization to be given for each species, but the following key, when taken in connection with hosts and geographical data, will provide some aid to those persons who desire to determine their collections.

Teliospores slender, 8–11-celled.
- Walls of aecio- and urediniospores thin, 1–1.5 μ.
  - Teliospores long, 80–100 μ. — 1. *P. americanum* Diet.
  - Teliospores very long, 90–130 μ. — 2. *P. Rosae-setigerae* Diet.
- Walls of aecio- and urediniospores thick, 2–3 μ.
  - Teliospores long, 90–112 μ. — 3. *P. Rosae-californicae* Diet.

Teliospores stout, 5–9-celled.
- Walls of aecio- and urediniospores medium, 1.5–2 μ.
  - Teliospores 5–8-celled. — 4. *P. Rosae-arkansanae* Diet.
  - Teliospores 6–9-celled. — 5. *P. montivagum* Arth.
- Walls of aecio- and urediniospores thick, 2–3 μ.
  - Teliospores 5–7-celled. — 6. *P. disciflorum* (Tode) James

These six species of *Phragmidium* have a most interesting distribution, both as to hosts and territory. The one species coming from Europe occurs chiefly upon thick-leaved roses of the dog and cabbage rose sections, *Rosa canina* and *R. Gallica*, their allies and hybrids, and appears to follow wherever these roses are cultivated. It is known throughout the United States from the Atlantic to the Pacific, northward into Canada, and southward into Mexico and Central America. It does not appear to have passed over to any native rose.

The distribution of the five indigenous species is shown by the accompanying chart. *P. americanum* inhabits the northeastern region along the Atlantic coast from Maryland northward and north of the great lakes, chiefly on *Rosa blanda*, *R. lucida*, *R. Sayi*, and certain cultivated varieties derived from these. *P. Rosae-setigerae* is only known upon *Rosa setigera* and *R. carolina*, extending nearly throughout the region of the hosts from central New York to central Nebraska. *P. Rosae-arkansanae* is only known

on the prairie rose, formerly called *Rosa arkansana*, now known as *R. pratincola*, and extends from northern Illinois to Kansas and northward. *P. montivagum* is found in the Rocky Mountains from southern Colorado and Salt Lake in Utah northward. It occurs on all or nearly all the many species of native roses of this region, having been reported on *Rosa Bakeri*, *R. Fendleri*, *R.*

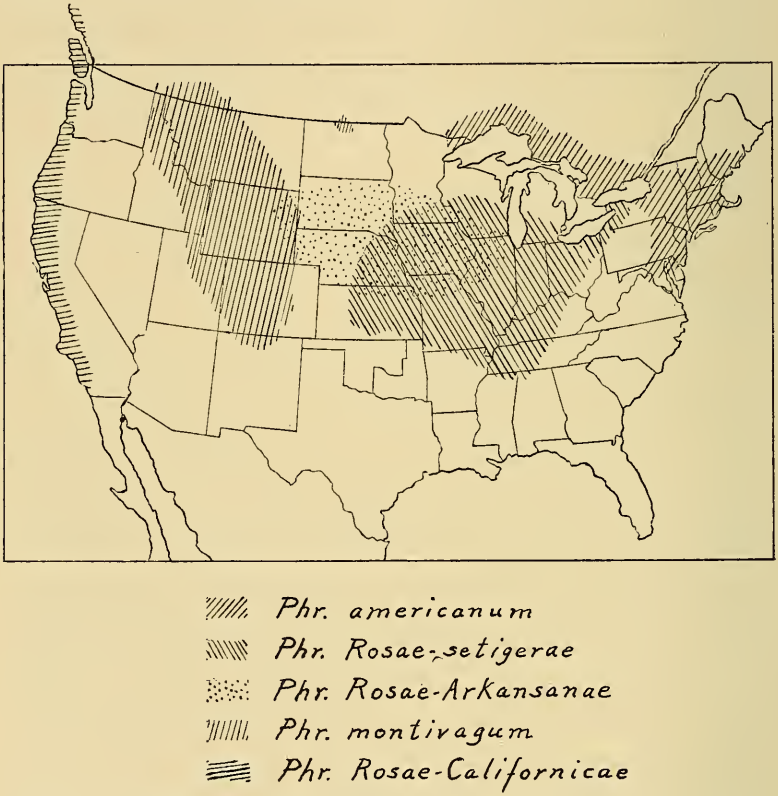


FIG. 3. Distribution of the five American species of *Phragmidium* occurring on native roses.

*grosse-serrata*, *R. manca*, *R. Maximiliani*, *R. Sayi*, *R. Underwoodii*, *R. Woodsii*, and others. *P. Rosae-californicae* extends along the Pacific coast from southern California to southwestern Alaska, on *Rosa californica*, *R. gymnocarpa*, *R. pisocarpa*, and *R. acicularis* chiefly.

It will be observed that there are large areas from which no

native rose rusts are reported, notably all the southern region, and the plateau between the Sierra and Rocky Mountains. Probably this is in part due to the sparseness of native hosts in these areas, to the oversight of collectors, or it may be to the absence or rarity of the rusts because of unfavorable conditions. At present it is only possible to call the attention of observers to this hiatus in our knowledge.

The especially prominent feature brought out in the study of the native rose rusts is the remarkable parallelism between them and their hosts in regard to geographical distribution and specific variability. Each species of rust inhabits one species of host or a group of species of similar physical characteristics, and ranges over quite definite areas, usually nearly coextensive with the range of the respective hosts. Probably the most variable species of all is *P. montivagum* of the Rocky Mountains, and it is also true that the roses on which it occurs form the most intricate complex of ill-defined species known to North America. Furthermore, intergrading forms are not infrequent between the mountain species, *P. montivagum*, and the prairie species, *P. Rosae-arkansanae*, along the foothills of Colorado and Wyoming, just as intergrading forms of the hosts also occur along this tension line.

In explanation of these facts probably many of the ecological factors controling the distribution of the hosts on which the rusts occur would also have a bearing on the distribution of the rusts themselves. It is not possible, however, to resist the impression that one of the chief factors is the intimate relation between host and parasite. Whatever the nature of this relationship may be, and it would be difficult to define it, it permits of a certain thriftiness of the parasite in proportion to the susceptibility of the host. Any tendencies to variability in the parasite must therefore be accentuated by changes in the host. That the variability in the parasite does not originate through any qualities in the host probably needs no proof, but has an admirable illustration in this connection. *Earlea speciosa* is found abundantly throughout all the territory and upon all the hosts inhabited by the five species of *Phragmidium*, and yet shows no marked variations, whether

comparison is instituted between specimens from widely separated regions, or from strongly dissimilar hosts. This species of *Earlea* possesses an aecium exactly comparable in appearance and habit of growth with that of the species of *Phragmidium* under discussion; and in other ways a near relationship is evident.

The fixity of characters in *Earlea* and the high variability in *Phragmidium* as shown in American rose rusts present an interesting contrast. Regarding the latter it may be safely asserted that each species of *Phragmidium* has attained a degree of orthogenetic development and a diversity of characters corresponding to those of the hosts on which it occurs, always, however, with a certain lag due to the inhibiting nature of parasitism.

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## THE PERENNATION OF THE CLOVER DODDER, CUSCUTA EPITHYMUM MURR *

By F. C. Stewart and G. T. French

In almost all botanical writings the numerous species of *Cuscuta* are all classed as annuals. It appears to be the prevailing opinion that none of the dodders survive the winter in the thread form and that, in order to perpetuate themselves, they must start anew every year from seeds. Yet, so long ago as 1868 Dr. Julius Kühn made the announcement,† based on his own observations, that clover dodder, *Cuscuta Trifolii* (= *C. Epithymum*), lives over winter on clover and alfalfa plants in Germany. Also, Sorauer, in the second edition of his well-known Handbuch der Pflanzenkrankheiten, published in 1886, states that clover dodder is not annual but perennial, and that on perennial plants it perpetuates itself more often by the further growth of the previous year's dodder plants than by the germination of new seeds. On the other hand, Frank,‡ ten years later, makes an equally positive statement that the dodders are all annual plants that start anew every year from seed. In 1900 Kühn

* Read before Section G of the American Association for the Advancement of Science, Baltimore Meeting, December 31, 1908.

† Ztschr. landw. Centralvereins der Provinz Sachsen 25 : 238.

‡ Die Krankheiten der Pflanzen, Zweite Aufl. 2 : 523.